

Hinks. Some of the more recent American lamps exhibit decided improvements in the details of construction of the oil reservoirs, the wick-holders and elevators, the arrangement for extinguishing the lamps, &c.

It does not come within the province of this discourse to deal with the marvellous development of the petroleum industry in America, where the region of Western Pennsylvania now furnishes about 70,000 barrels of oil per day, having up to January 1, 1884, yielded a total of 250,000,000 barrels. Nor would it be relevant to enter upon the equally interesting topic of the recent extraordinary progress of the same industry in the Caucasus, which is chiefly due to Messrs. Nobel Brothers, further than to refer to the fact that the Baku petroleum lamp oil, which supplies the entire wants of Russia, and is gradually obtaining a footing in Germany, and even here, appears, notwithstanding its comparatively high specific gravity, to be adapted for use in mineral oil lamps of the ordinary construction. This seems to be partly owing to the comparatively small proportion of lamp oil that is extracted from the crude Baku petroleum, in consequence of which the variety of hydrocarbons composing that product of distillation which is used for illuminating purposes, presents a narrower range than is the case in the ordinary American petroleum oil of commerce. It has also been established by careful observations which Beilstein has instituted, that some American oil which is specifically lighter than the Baku oil is not so readily carried up to the flame as the latter, by the capillary action of the wick. Mr. Boverton Redwood has carried out some instructive experiments, employing different kinds of wick as siphons, and measuring the quantity of different descriptions of oil drawn over in corresponding periods of time by the different wicks. These showed that the Baku kerosine was drawn over with decidedly greater rapidity than samples of American petroleum of ordinary quality, but that, on the other hand, a sample of American kerosine of the highest quality exhibited a corresponding superiority over the Baku oil experimented with. The nature and behaviour of the wick plays a most important part in determining the efficiency and also the safety of a mineral oil or petroleum lamp, as will be presently pointed out.

Ever since paraffin or petroleum oils, which may be included under the general designation of mineral oils, first assumed importance as illuminating agents, accidents connected with their use have continued to claim prominence among those casualties of a domestic character which tend to cast suspicion on the safety of the material dealt with, or of the method of employing it, under the ordinary conditions fulfilled by its careful use.

The employment as an illuminant of the most volatile portions of petroleum which are classed as spirit or naphtha, has been chiefly limited to the wickless Holliday lamp, in which a small continuous supply to a chamber heated by the lamp flame which surrounds it, furnishes the vapour which maintains that flame, and to the small so-called sponge lamps or benzoline lamps, of which the body is filled with fragments of sponge, and which is intended to be charged only with as much spirit as the sponge will hold thoroughly absorbed; the small flame at the top of the wick-tube being fed by the gradual abstraction of the liquid from the soaked sponge, by the wick of sponge or asbestos which fills the tube. An ingenious application of naphtha as an illuminant consists in filling a reservoir with sponge fragments kept soaked with the spirit, the vapour of which descends by its own gravity through a narrow tube at the base of the reservoir, and issues from a fish-tail burner under sufficient pressure to produce a steady flame for some time.

(To be continued.)

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, March 12.—J. W. L. Glaisher, F.R.S., President, in the chair.—Messrs. Philip Magnus and R. Lachlan were elected Members.—Mr. J. J. Walker, F.R.S., made a second communication on a method in the analysis of plane curves.—Mrs. Bryant, D.Sc., read a paper on the geometrical form of perfectly regular cell-structure. "Investigation of the properties of the rhombic dodecahedron supplies the clue to the solution of two interesting questions, which are the essential, because the pure geometrical, constituent of several questions as to actual forms in physical nature, such as the geometrical structure of compact tissues on the one hand, and the

geometrical form of the honeycomb cells on the other hand. The first question is as follows:—If space were filled with spheres, and this space of spheres were then crushed together symmetrically till the whole became a solid mass, what shape would each sphere ultimately assume? Since twelve is the number of spheres that can be placed round one sphere, in contact with it and with one another, it is evident that each of these ultimate solids would be dodecahedral in shape. The second question is the counterpart of the first:—If space were filled with a homogeneous solid, in which equally efficient centres of excavation were distributed uniformly, what would be the ultimate form of the cells excavated, it being supposed that when the excavators cease their work the walls of the cells are uniform in thickness? The answer to the first question is manifestly the answer to this second question also." After a geometrical discussion the author says:—"We should expect to find this dodecahedral shape in nature wherever originally spherical cells have been uniformly pressed together in a complete manner. The condition is probably seldom fulfilled, and examples are therefore difficult to find. We may look for their fulfilment, however, in the centre of a mass of soap-bubbles." The paper then considers the case of the honeycomb cells, with the conclusion: "The above explanation tends, however, to show that the bees need not be credited with any economical instinct to account for their work, but only with those simpler instincts, which enable them to carry out a joint work with perfect regularity and exactness, which simpler instincts, while sufficiently remarkable, are fairly within the limits of credibility."—Mrs. Bryant illustrated her remarks with several models of the cube and the rhombic dodecahedron.—Mr. Kempe, F.R.S., and the President (who stated that he had some few years since considered the matter from another point of view) made some interesting remarks in connection with the subject.—Prof. Sylvester, F.R.S., gave an account of a paper on the constant quadratic function of the inverse co-ordinates of $n + 1$ points in space of n dimensions; and Prof. Cayley, F.R.S., and Prof. Hart spoke on the same subject. As the hour was late Mr. Tucker (hon. sec.) merely communicated the titles of papers by Prof. K. Pearson (on the flexure of beams); Rev. T. C. Simmons (two elementary proofs of the contact of the "N.P." circle of a plane triangle with the inscribed and ascribed circles, together with a property of the common tangents); and by himself (two other proofs of the first part of Mr. Simmons's communication).

Linnean Society, March 5.—Sir J. Lubbock, Bart., President, in the chair.—Messrs. Jas. Epps, Jas. Groves and Wm. Ransom were elected Fellows of the Society.—Mr. E. M. Holmes exhibited a number of new species of British algæ, viz. thirteen from the south coast of England, and six obtained from Berwick-on-Tweed and Fifeshire. He also called attention to examples of the leaves of *Eucalyptus Staggeriana*, which are remarkable for their fragrant odour, resembling that of verbenæ, due to a volatile oil which is stated by Mr. Bailey, the Government botanist at Brisbane, to be likely to form an article of commerce in the future. Mr. Holmes also showed a set of plant labels made from the leaves of the Taliaf palm. Mr. W. Brockbank exhibited a specimen of *Leucojum carpathicum*, a variety of *L. vernum*, differing from the type by having the flowers tipped with yellow instead of green. The *L. carpathicum* is said now to be seldom met with in English nurseries.—Mr. C. B. Plowright showed and made remarks on a Ranunculus infected with spores of *Urocystis pompholigodes*.—Mr. E. Wethered exhibited some microscopic sections of the "Better Bed" coal-seam of Yorkshire and of the "Splint" coal from Whitehill Colliery, near Edinburgh. He mentioned that Prof. Huxley had drawn attention to the former as containing in quantity sporangia and spores of plants allied to the recent club mosses. Mr. Wethered averred that these were only found in numbers in the topmost three inches of the coal-bed, but very sparsely in the lower portion of the seam. In the Edinburgh splint coal only four inches of the basal and but a part of the upper layer contained spores. Macrospores and microspores were present in both the coals, and, judging from these, he regarded them as belonging to plants resembling or allied to the recent genera *Selaginella* or *Isoetes*. Mr. W. Carruthers replied, and dissented from this view.—Dr. F. Day read a paper on the rearing, growth, and breeding of salmon in fresh water in Great Britain. He referred to the statements and opinions of the older authorities, and then dwelt more at length on the more recent experiments of Sir James Maitland at Howietoun. In December, 1880, Sir James

obtained salmon eggs and milt from fish captured in the Teith, and which ova hatched in March, 1881. In July, 1883, it was seen that some of the young salmon, then two years and four months old, were either in the parr livery or had assumed the dress of silvery smolts, the latter in certain lights showing parr bands. On November 7, 1884, a smolt $1\frac{1}{2}$ lbs. weight jumped out of the pond, and from it about 100 eggs were expressed, and as they seemed to be ripe they were milted from a Lochleven trout.—On January 23, 1885, eighteen of these eggs hatched; the young were strong and healthy. November 11, 1884, about 12,000 Lochleven trout eggs were milted from one of the foregoing smolts, and they hatched January 28, 1885. December 1, 1884: 1500 eggs were taken from two of the foregoing smolts, and treated by the milt of one of the males. On the 9th, about 4000 eggs from these smolts were fertilised from one of the males, and on the 13th, 2500 smolt eggs were milted from a parr. Dr. Day further stated that pure salmon eggs in the Howietoun Fishery have been hatched, that the young have grown to parr, smolts, and grilse; that these latter have given eggs, and their eggs have been successfully hatched. Although time will yet be necessary before a definite reply can be given as to how these young salmon will thrive, how large they will eventually become in fresh water ponds, and whether from them a land-locked race may be expected—still the following points seem to be established. That male parrs or smolts may afford milt capable to fertilise ova; but, if taken from fish in their second season at thirty-two months of age, they are of insufficient power to produce vigorous fry. That female smolts, or grilse, may give eggs at thirty-two months of age, but those a season older are better adapted for the production of vigorous fry, where, to develop ova, a visit to the sea is not a physiological necessity. That young male salmon are more matured for breeding purposes than are young females of the same season's growth. That female salmonidæ under twenty-four months of age, although they may give ova most, are of little use for breeding purposes, the young, if produced, being generally weak or malformed. That at Howietoun, so far, hybrids between trout and salmon have proved to be sterile. Furthermore, it was stated that the size of eggs of salmonidæ vary with the age and condition of the parent, but as a rule older fish give larger ova than younger mothers. Even among the eggs of individual fish, variations occur in the size of the ova. From larger ova finer and rapidly growing fry are produced, consequently by a judicious selection of breeders, races may be improved, but it is only where segregation is efficiently carried out that such selection is possible.—A paper was afterwards read, Notes on some recently-discovered flowering plants from the interior of New Zealand, by the Rev. W. Colenso. In this the author describes and gives field notes on some eighteen supposed new species.

Institution of Civil Engineers, March 3.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was on the construction of locomotive engines, and some results of their working on the London, Brighton, and South Coast Railway, by William Stroudley, M.Inst.C.E. The author, on his appointment to the London, Brighton, and South Coast Railway, in 1870, had to consider what kind of locomotive engine and rolling stock would best meet the requirements of the service; as, owing to the great increase and complication of the lines and traffic, the original primitive engines and rolling stock were not able to do so. He, therefore, in the same year designed a large goods engine, class "C," arranging the detail so that they would enable him to construct the several classes illustrated, all the principal parts being interchangeable. Having had long experience with both outside- and inside-cylinder engines, he adopted inside cylinders, but placed the crankpins for the outside rods on the same side of the axle as the inside crank, the outside pin, however, having a shorter stroke; and he thus obtained the advantages of both systems. He adopted the method of putting the coupled wheels in front, instead of at the back as usual, which permitted the use of small trailing wheels, lightly weighted, and a short outside-coupling rod for the fast running engines, and also a much larger boiler than could be obtained when the coupled wheels were at the back. The author adopted a somewhat high centre of gravity, believing that it made the engine travel more easily upon the road, and more safely at high speeds; the slight rolling motion, caused by the irregularities of the road, having a much less disturbing influence than the violent lateral oscillation peculiar to engines with a low centre of gravity. The high centre of

gravity also threw the greatest weight upon the outside or guiding wheel when passing around curves; and this relieved the inner wheels, and enabled them to slip readily. The author used six wheels in preference to a bogie for these engines, to avoid complication and unnecessary weight. The engines were very light for their power. Spiral springs were used for the middle axle, and these had a greater range than the end ones for the same weight. The two cylinders of the large engines were cast in one piece, with the valves placed below, giving lightness, closeness of centres, and easy exhaust and steam-passages. The crank-axle was the only disadvantage left in an inside cylinder, inside framed engine, and, when this was of good proportions, it offered but a small objection. Owing, however, to the narrow gauge of the rails in this country, the crank-axle could not be made so strong as it ought to be, or there would be no reason why a crank-axle should break. When the flanges of the driving-wheels were turned down thin, so as to avoid the side-shock given by crossings and check-rails, there only remained the strain of the steam upon the pistons to cause breakage; the action of this was precisely the same as the methods used by the late Sir William Fairbairn in testing to destruction the model tube for the Menai Bridge, by letting a heavy weight rest upon it suddenly at frequent intervals. The deflection, if sufficient, caused a crack at the weakest place, which gradually extended until fracture took place. This was precisely what occurred in the axle; the crack invariably commencing on the side of the axle opposite to that to which the steam was applied. The author, after thirty years' experience, believed that the separate parts of locomotives, including tires, axles, piston-rods, side-rods, bolts, cotters, and carriage and wagon axles, broke from the same cause; they did not break when carefully designed, and made with proper materials and workmanship. As the crank-axle could not be made of the proper strength, it was well to consider how to avoid, as far as possible, risk of accident by its failure. By making the axle-boxes and horn blocks deep and strong, giving large flat surfaces against the boss of the wheel and the outside of the crank arm, the driving-wheel was kept in position after the axle was broken, if the fracture occurred in the usual place, namely, through the inside web, near the crankpin, or through the centre part where it joined the inside web. An axle, broken in this manner, would run safely over any part of the road, except at a through-crossing, where the guiding-rail was lost, and the flange was liable to take the wrong side of the next point; this, however, had not happened in the author's experience. The author had always hooped the larger cranks, and had for some time hooped every new crank in the same proportion as adopted on the Great Northern Railway, thus reducing the risk to a minimum. The engines had been arranged that part of the exhaust steam might be turned into the tender or tanks, so that the feed-water might be heated. This was a special advantage in a tank engine, by increasing the total quantity of water; it also kept the water supply of greater purity, and it relieved the boiler of a certain amount of duty in heating the water from the ordinary temperature to that which feed-water required. The feed-pumps had been designed to meet the requirements of pumping hot feed-water. The proportions of the valve-gear gave an admission of 78 per cent. of steam in full gear, which could be reduced to 12 per cent. with excellent results; and as at high speeds the steam was never exhausted, the temperature of the cylinder was maintained, and as much steam was locked up in the cylinders as raised the pressure at the end of the stroke to near that in the steam chest. This made the engine run very smoothly at high speeds, and turned what would otherwise be an extravagant coal-burner into an economical machine. And for the same reason the compounding of fast-passenger or frequent-stopping locomotives was not likely to show much, if any, economy over a well-designed, simple engine. The case was different, however, in heavy goods engines, working with a late cut-off most of the time, and where the conditions approximated closely to those of a land or marine engine with a constant load. The back-pressure observed in the diagrams of high-speed locomotives was not therefore a defect, but an advantage, and the author accordingly used small steam-ports and short travel of slide-valve. These remarks as to back-pressure did not apply to the pressure in the exhaust pipes, where it should be as small as possible, but only to the back-pressure in the cylinder. The latter was greatest at high speeds, when a small volume of steam was passing through the cylinders, and small power was required, and least when

working full power with the smallest expansion. All the passenger engines and many of the goods engines were fitted with the Westinghouse automatic air-brake, as were also the whole of the carriages. This brake gave entire satisfaction and complete control of the trains. The author took considerable pains with the fittings and details when it was first introduced, and arranged the gear for the engines, so that the brake acted upon each wheel independently, allowing the springs freedom to act; or it acted upon the front of all the wheels, as in the tank engines, the brake of which was moved by hand as well as by the air-pressure. The Westinghouse air-pump had been fitted with a plunger at the bottom end of the rod, $1\frac{3}{4}$ inches in diameter, and this pumped water into the boilers of the goods engines when they were in sidings or were delayed by signals. For the express and large goods engines the greatest possible amount of heating-surface had been provided; the fire-box was capacious, with small tubes of considerable length in proportion to their diameter, little or no flame being generated with the coal used, and a very small amount of soot. The fuel which was found cheapest to consume in this locality was smokeless coal from South Wales, mixed with a small quantity of bituminous coal from Derbyshire. The boilers were made of the best Yorkshire iron, with plates having planed edges; holes were drilled after the plates had been bent; the joints were butt-joints, and they were hand-riveted. The construction of the ash-pan and its dampers, perforated plates, water-supply, and the arrangement of fire-bars, brick arch, fire-door, and deflector, was shown. The indicator diagrams, taken by one of the Crosby Steam-Gauge and Valve Company's indicators, at various speeds, and under varying conditions of gradient, afforded a fair idea of the working capabilities of these engines, the economical value of which was best shown by quoting the consumption of fuel for the half-year ending June 30, 1884, when the average of the whole of the engines on this line was 29.74 lbs. per engine mile, including the coal used in raising steam. A great number of careful tests had been made of the amount of coal required to raise steam in the engines from cold-water, and also from the partially heated water when the boiler had not been emptied, and this amounted on an average to about 3 lbs. per mile run. Some doubts had been expressed as to the value of heating feed-water by the exhaust steam. The author, therefore, had a number of tests made with the ordinary heating-apparatus removed, and water fed to the boilers by the feed-pumps, and in one series by a Borland's injector. The amount of power required to work the pumps was inappreciable; and the heated feed-water brought about reduction in the consumption of fuel to the extent of over $2\frac{1}{2}$ lbs. per train-mile. It had also been found that heating the feed-water by direct contact of the steam did not, on this railway, injuriously affect the boiler-plates. With a view to ascertain what was the amount of power required to haul a train from Brighton to London, a complete set of 49 diagrams was taken from the engine "Gladstone," working an express train of twenty-three vehicles; the total weight of train and engine being 335 tons 14 cwt. A section of the line was given, and clearly illustrated the result, giving the H.P. at about every mile, the speed, and the gradient. The temperature of the gases in the smoke-box was taken at frequent intervals; also the degree of vacuum in the fire-box and in the smoke-box, and the quantity of water used out of the tender. To the latter had to be added the water condensed from the exhaust, which, from experiments, the author estimated at 20 per cent. This gave an evaporation of 12.95 lbs. of water per 1 lb. of coal, and 1 lb. of coal would convey 1 ton weight of the train $13\frac{1}{2}$ miles, at an average speed of 43.38 miles per hour, over the Brighton Railway, the rate of consumption being 2.03 lbs. of coal per H.P. per hour.

Chemical Society, March 5.—Dr. W. H. Perkin, F.R.S., President, in the chair.—The following papers were read:—On the conversion of Pelouze's nitrosulphates into hyponitrites and sulphites, by Prof. E. Divers, M.D., and Tamemasa Haga.—On the constitution of some non-saturated oxygenous salts and the reaction of phosphorus oxychloride with sulphites and nitrites, by Prof. E. Divers, M.D.—The illuminating power of hydrocarbons. I. Ethane and propane, by Percy F. Frankland, Ph.D., B.Sc.—On benzoylacetic acid and some of its derivatives, Part III., by Dr. W. H. Perkin, jun.

Anthropological Institute, March 24.—Francis Galton, F.R.S., President, in the chair.—The election of the following gentlemen was announced:—F. D. Mocatta, the Hon. Cecil

Duncombe, J. G. Frazer, M.A.—A paper was read by Mr. A. J. Duffield on the inhabitants of New Ireland and its archipelago. The author first dealt with the assumption that the inhabitants of these islands are the descendants of remote but superior races, that they retain inherited powers which have become weak by lack of use, and that these moral and intellectual powers can be easily restored. The food of the natives is chiefly vegetable, but they now and then eat the flesh of the small native swine—the opossum—and poultry, which is abundant. The climate is humid and unhealthy; the people poor in flesh, small in size, and light in weight. Their usual colour is a dark brown, but they are a mixed race; the hair is crisp and glossy. The tattooing and cuttings on the flesh are confined to the women and the headmen. The men go absolutely nude, but the women wear "aprons" of grass before and behind, suspended from cinchures made of beads strung on well-made thread; they bleach their hair and paint their bodies with coloured earths. They speak a language which is at once musical and familiar, in which is found a fair sprinkling of Arabic and Spanish words.—Mr. R. Brudenell Carter read a paper on vision-testing; and Mr. C. Roberts read a paper on the same subject.

DUBLIN

Royal Society, January 19.—Section of Physical and Experimental Science.—Prof. C. A. Cameron, M.D., in the chair.—Prof. Emerson Reynolds, M.D., F.R.S., gave a short account of the selenium analogue of the sulphur urca—thiocarbamide—he discovered some years ago. The author, having recently prepared a considerable quantity of cyanamide, and being aware that other chemists had failed to produce selenocarbamide by the molecular change of ammonium selenocyanate, decided to examine the action of hydrogen selenide on cyanamide, as it is well known that thiocarbamide can be easily formed

according to the equation
$$\text{H}_2\text{S} + \begin{matrix} \text{CN} \\ | \\ \text{H} \end{matrix} \text{N} = \text{CS} \begin{matrix} \text{NH}_2 \\ | \\ \text{NH}_2 \end{matrix}$$
 Four

grams of cyanamide were dissolved in 50 ccs. of anhydrous ether and a slow current of hydrogen selenide was passed through the solution under a pressure of about 60 mms. of mercury. The gas was slowly absorbed, and at first some selenium separated from the liquid, but on continuing the treatment beautiful colourless crystals separated on the sides of the vessel. The crystals were drained from the ethereal liquid, and when exposed to the air were found to be easily reddened by the action of light; they were dissolved in a small quantity of hot water, the solution filtered, and then cooled, when beautiful silky crystals separated which very closely resembled thiocarbamide in appearance and mode of crystallisation. The purified compound proved to be $\text{CSe}(\text{NH}_2)_2$. The author learned, however, from the January number of the *Journal of the Chemical Society of London* that M. A. Verneuil had just published an account of the same body in the *Bulletin of the Paris Society*. Dr. Emerson Reynolds, therefore, did not continue his investigation, as he believed M. Verneuil to be fully entitled to priority, but contented himself with the exhibition to the society of the specimen of selenocarbamide produced in the Dublin University Laboratory.—On a model illustrating some properties of the ether, by Prof. G. F. Fitzgerald, M.A., F.R.S. The model consisted of a series of wheels arranged at equal distances along parallel rows on axes fixed perpendicularly into a board. The wheels were connected together by indiarubber bands, each wheel being so connected with its four neighbours. Under these circumstances it was shown that if any wheel were turned all the wheels turned simultaneously, and that, except for friction on the axes, &c., they would all turn equally. It was explained that the model only exhibited properties of the ether itself and did not exhibit the connections of matter with ether. A region within which the bands did not slip represented a non-conducting region, and differences of elasticity of the bands represented differences of specific inductive capacity, slipping of the bands represented a conducting region, and complete absence of bands represented a perfectly conducting region. When bands were removed from a certain region and all around it a line of bands left, and all around outside this again a conducting region, then if a conducting line connected these regions the wheels along this line might be turned in opposite directions, and when this is done all the non-conducting region is thrown into a state of stress by all the wheels not rotating equal amounts, in which the bands are tight on one side of a pair of wheels and loose on the opposite side. It was explained that this exhibited the

polarisation of the medium between two oppositely charged conductors, the direction of polarisation being at right angles to these bands—*i.e.*, in the line joining the conductors—the medium in this state representing a charged Leyden jar, the two opposite electrifications being represented by the tight and loose bands, one conductor being bounded entirely by tight bands and the other by loose ones, and the electric displacement of Maxwell being represented by the difference between the two sides of a band. If the bands along any line between the two conductors slipped, all the energy of the medium was spent along this line in friction, and this represented a discharge along the line. This energy was conveyed into the line of discharge by its side and not along its length in accordance with what Prof. Poynting has recently shown to be the case in all electric currents. If the resistance along the line of discharge were sufficiently small the momentum of the wheels would carry them beyond their position of equilibrium and the well-known phenomenon of an alternating discharge would be represented. This led to the observation that the magnetic displacement was represented by the angular velocity of rotation of the wheels and the self-induction by their momentum. It was remarked that the mechanical attraction between the two conductors was not represented, but it was explained that as this depends on the connection of matter with ether it would require more complicated mechanism. It was, however, pointed out that by supposing the wheels slightly distorted by the stress, and by supposing a thread wound around them and each end connected with the material of a conductor, a force would be produced drawing the conductors together owing to the circumference of a distorted wheel being longer than of an undistorted one. This force would be proportional to the square of the distortion, a necessary condition not satisfied by ordinary stresses, and would be, if exerted between two infinite planes, independent of their distance apart, and so must represent a force varying inversely as the square of the distance. Returning to the electric currents, it was shown that by turning the wheels at any point of a conducting circuit the whole region was filled with turning wheels—*i.e.*, with magnetic displacement—and that, if a resistance were introduced at any point of the circuit, the energy would be transferred to that point through the medium and enter by the side of the conductor. If two independent conducting circuits existed near one another it was shown that the phenomena of induced currents were represented. It was explained that the mechanical force was not represented, as it depended upon the connection between matter and ether, but that it might be looked for as in some way depending on the centrifugal force arising from the rotations. The equations representing the energy of the model are of the same form as those of Maxwell representing the energy of the ether when limited by the consideration that the model was only in one plane. It was explained that a tridimensional model whose energy could be represented by the same equations as Maxwell's could not be constructed with indiarubber bands, but might be constructed by means of wheels pumping fluid through pipes. This led to the observation that the propagation of waves by transverse vibrations could be illustrated by the model, and it was explained how a sudden turning of any set of wheels would start a wave-propagation whose direction of propagation was at right angles to the directions of magnetic displacement and of electric displacement, the former represented by the axes of rotation and the latter by the line joining the centres of a tight and loose band. It would be possible theoretically to construct a model illustrating the laws of reflection and refraction of light even at the surfaces of crystalline media, and to reproduce conical refraction. It was explained that by twisting the medium the rotatory polarisation of quartz might be represented, and that probably a mechanism might be introduced by which the rotation of other wheels or of something besides the wheels being altered by the rotation of the wheels, a reaction of the former on the latter would reproduce magnetic rotatory polarisation. It was pointed out that both magnetic rotatory polarisation and dispersion were due to a reaction of the medium during the wave-propagation and not to a change of the medium independent of the wave-propagation. It was explained that it was not to be supposed that the ether was constructed of wheels and indiarubber bands, nor even of wheels pumping fluid in pipes, but it was pointed out that some properties of the ether might be gathered from the model if it be assumed that the qualities of the ether represented by symbols obeying the laws of rotation for instance are really of the nature of rotation. If this be so the ether must be such that any part

of it can rotate as often as it likes provided all the neighbouring parts rotate equally and the electrostatic stresses in the ether must be due to the difference of rotation of its parts. If the ether be a perfect liquid it can only have such properties as represent rigidity by being in motion, and it was explained that many electrical phenomena might be illustrated by the polarisation of the vortical motions in a vortex-sponge. Sir Wm. Thomson has pointed out that such a state of polarisation as a single vortex region in the centre of a cylindrical box will not of itself change unless it can spend its energy on the box, which is quite analogous to the fact that the energy of the polarisation of the ether does not disappear unless it can produce heat or mechanical or other forms of energy. It was also pointed out that forces depending on small vortices vanished at small distances from them and that hence the forces depending on their polarisation between two infinite planes would depend on the polarisation and not on the distance between the planes, and so must be of the nature of forces varying inversely as the square of the distance. It was explained that the modes of polarisation of vortices were sufficient to explain both electrical, magnetic, cohesion and chemical forces. It was finally reiterated that the only possible way of giving anything of the nature of rigidity to a perfect liquid was by conferring motion on it and that it seemed likely that any mechanical properties could be conveyed by suitably chosen motions. This was quite in accordance with Sir Wm. Thomson's suggestive address to Section A at Montreal.

Natural Science Section.—V. Ball, M.A., F.R.S., in the chair.—On the physical characters of calcareous and siliceous sponge spicules and other structures, by Prof. W. J. Sollas, M.A., D.Sc., F.R.S.E., F.G.S.—The refractive index of a siliceous sponge spicule, diatom, or other siliceous organic body is determined by immersing it in liquids of different refractive indexes until one is found in which it ceases to be visible under the microscope. The refractive index of this liquid gives that sought for. The siliceous matter of organisms has a refractive index of 1.449, which is that of some kinds of opal or colloidal silica. The refractive indexes of calcareous sponge spicules are found in a similar manner, but as these are biaxial it is necessary to examine them between crossed Nicols; $n_r = 1.485$, $n_o = 1.659$. These indexes agree with those of calcite. This method of obtaining refractive indexes is applicable to mineral bodies; the glass of the Krakatoa explosion is thus found to have a refractive index of 1.51. Leucite can be thus readily distinguished from analcime and calcite from aragonite. The specific gravity of calcareous spicules (1.62) and that of foraminifera were found by an adaption of the Sonstedt solution method to use with the microscope. The perforate foraminifera have a sp. gr. of 2.65 to 2.67, the imperforate of 2.7 to 2.72, calcite being taken as 2.7. The structure of calcareous spicules was shown by a study of the extinction angles between crossed Nicols, by the development of cleavage planes, and each figure to be purely crystalline. Each spicule is a single calcite individual with its optic axis definitely related to its form. The acerate spicules of calcisponges are distinguished from those of the siliceous sponges by their form, the former often presenting an oval or rhomboidal transverse section. The large spicules of the Pharetrones agree with those of the Calcisponges, with which, therefore, this fossil group must be associated.—On some Trilobites from the Cambro-Silurian rocks of the County Clare by W. H. Bailly, F.C.S.—Notes on the coalfields of Leinster and Tipperary by G. H. Kinahan, M.R.I.A.

CAMBRIDGE

Philosophical Society, March 2.—Prof. Foster, President, in the chair.—The following communications were made:—On some theorems in tides and long-waves, by the Rev. E. Hill. Elementary considerations were given from which it might be inferred that when a disturbing body produces a semi-diurnal tide in an equatorial canal, the point nearest to the disturbing body will be a point of low tide or high tide according to the depth of the canal. A general explanation was given of the influence of the depth of a canal on the speed of a long wave traversing it. It was shown that the ordinary formula for this speed might be deduced from the ordinary differential equation of motion without integration.—On the electrical resistance of platinum at high temperatures, by Mr. W. N. Shaw.—On an automatic mechanical arrangement for maintaining a constant high potential, by Mr. Threlfall. A water-motor of the Thirlmere type is allowed to settle down to a constant velocity by means of the resistance of a fan which is worked by the motor.

The motor thus governed rotates a shaft on which is a copper disk and two pulleys. The copper disk is placed between the poles of a large electro-magnet: and the second pulley serves to give motion by means of an india-rubber band to a replenisher whose dimensions are determined by the special conditions of the experiment for which the apparatus is to be employed. The regulator, mounted on a box in which is a condenser, consists of a fixed and movable disk, the latter suspended from a spiral spring and carrying a wire across its back turned down at its two ends. The disks are connected with the poles of the condenser, the movable one being put to earth. By means of a Weber suspension arrangement mounted on the top of a guard-hole which protects the spiral spring from currents of air, the attracted disk can be adjusted so that when the difference of potentials arrives at the required value, the wire dips into two mercury cups and so short-circuits a high resistance. By this means a strong current is allowed to flow through the electro-magnet and act as a brake on the copper disk; this causes the velocity of the engine to change and a replenisher to revolve more slowly. When the potentials have fallen sufficiently by leakage or otherwise, the contact at the mercury cups is broken and the motor is enabled to rotate at a higher rate of speed. By this means the potential difference is kept between certain limits depending on the sensibility of the arrangement, and this is increased by having the disks close together and the contact points made of aluminium instead of platinum. Such an apparatus is of use in maintaining condensers, &c., subject to leakage at a constant high potential.

PARIS

Academy of Sciences, March 16.—M. Bouley, President, in the chair.—Reaction of bromine on the chlorides and on hydrochloric acid. A new class of perbromides by M. Berthelot. Fresh experiments made by the author show that the reaction of bromine on the chlorides always liberates heat in the same way as the inverse reaction. In both cases the transformation of the system is always exothermic. Hydrochloric acid and highly concentrated chlorides dissolve bromine in large quantities with liberation of heat, attesting the existence of combinations formed by addition (perbromides of chlorides).—A morphological comparison of *Limax* (*L. Agrestis*, *Cimereus* and *Gagates*) with *Testacella* (*T. haliotideae* and *Maugey*), by M. H. de Lacaze-Duthiers.—On the solubility of the sulphurets of carbon and of chloroform, by MM. G. Chancel and F. Parmentier. The solubility of the sulphuret of carbon in water is shown to diminish according as the temperature is raised. But that of chloroform presents a decreasing solubility from 0° to about 30° C., thenceforth increasing towards its boiling-point.—On the influence of the perturbations in determining the orbits of celestial bodies, by M. E. Vicaire.—A reply to M. Boiteau on the treatment of phylloxera and its winter eggs by washings and sulphur, by M. P. de Lafitte.—Records of the Scientific Mission to Cape Horn (1882-83); Vol. ii, Meteorology, by M. J. Lephay.—Note on the Abelian functions, by M. H. Poincaré.—On the theory of matrices, by M. Ed. Weyr.—On the canonical types of the ternary quadratic forms of differentials whose discriminant is null, by M. G. Königs.—On the electric differences between fluids, and on the part played by the atmosphere in the electrometric measurement of these differences, by MM. E. Bichat and R. Blondlot.—A thermo-chemical study of the fluosilicate of ammoniac: action of the fluoride of silicon on the fluoride of ammonium, and on ammoniac, by M. Ch. Truchot.—Description of a new process for hardening plaster of Paris, by M. Julhe. By the process here described a plaster is produced which may be substituted for wood in floorings, being equally durable and four times cheaper than oak.—Bromuretted substitution of phenolic hydrogen: bromuretted tribromophenol, by M. E. Werner.—On Fromherz's fluid, by M. E. J. Maumené.—On the chemical composition and therapeutic properties of *Artemisia gallica*, Wildenow, by MM. Ed. Heckel and Fr. Schlagdenhauffen.—Physiological action of the hexahydride of β -colladine or isocitidine, by MM. Rochefontaine and Echsner de Coninck. From experiments made on the frog and guinea-pig the authors find that this substance possesses a physiological action analogous to that of the alkaloid of hemlock (*Cicuta*). Hence they propose the alternative name of "isocitidine," recalling at once its chief chemical and physiological properties.—Definition, classification, and notation of colours, by M. J. Charpentier. A system of notation and classification is suggested, by means of which a thousand colours may be formulated by the series of natural

numbers from 0 to 999, where each cipher takes a precise meaning in virtue of its position. The name of the colour would simply be that of the number symbolising it, and the system might be called the "cubic classification," from the geometrical representation by which it may be best figured.—On the glands and lymphatic vessels entering into the constitution of the organ in birds known as the purse of Labricius, by M. Retterer.—On the physiological effect produced by the action of turning eggs during incubation, by M. Dareste. From experiments made with artificial incubators, the author finds that eggs not turned two or three times a day all perish invariably. The effect of this act on the embryo is explained, and the action of the bird accounted for on strictly physiological grounds.—Ores of the carbonate of zinc: their normal association with dolomitic formations explained, by M. Dieulafoy.—On the Miliolideæ of the Chalk formations, by MM. Munier Chalmas and Schlumberger. *Idalina*, *Periloculina*, and *Lacazina*, three new genera from the Upper Chalk of Provence, are described and affiliated to the family of the Miliolideæ.—The channels and lagoons on the east coast of Madagascar, by M. A. Grandidier. These inlets and lacustrine formations are explained by the position of the main water parting, which is usually placed about the centre of Madagascar, but which the author shows is situated much nearer to the east than to the west coast.

VIENNA

Imperial Academy of Sciences, January 22.—On the analysis of andesin of Frifail (Carinthia), by R. Maly.—On the self-purification of natural waters, by F. Emich.—On the action of bile acids on gluten and gluten "peptones," by the same.—On the products obtained by reduction of nitroazotic bodies, and on azonitrilic acids, by J. V. Janovsky.—On the astronomical knowledge of the South Arabian Cabyles, by E. Glaser.—On dehydracetic acid, by L. Haitinger.—Geological researches on the grauwacke formations of the North-East Alps, especially regarding the Semering region, by F. Toula.—On the meteorological observations made at the Austrian arctic station at Jan Mayen during 1882 and 1883, by A. Sobiezký.—On tide observations made in 1882-83 at Jan Mayen, by A. Bobrik.—On the survey of Jan Mayen carried out by the Austrian Arctic Expedition, by the same.

CONTENTS

	PAGE
Practical Physics	477
Malayan Antiquities. By Prof. A. H. Keane . . .	478
Our Book Shelf:—	
"The Antananarivo Annual and Madagascar Magazine."—Prof. M. Foster, Sec. R.S.	479
Letters to the Editor:—	
The Forms of Leaves.—Sir John Lubbock, Bart., M.P., F.R.S.	479
Aurora at Christiania.—Dr. Sophus Tromholt . .	479
"Peculiar Ice Forms."—W. J. McGee	480
Four-Dimensional Space.—S.	481
The Action of Very Minute Particles on Light.—J. Spear Parker	481
Fall of Autumnal Foliage.—Rev. Alexander Irving	482
Human Hibernation.—Col. C. K. Bushe	482
<i>Bos primigenius</i> .—Jas. Backhouse	482
The British Association and Local Societies . . .	482
Underground Noises heard at Caiman-Brac, Caribbean Sea, on August 26, 1883. By Dr. F. A. Forel	483
Remarks on our Method of Determining the Mean Density of the Earth. By Prof. Arthur König and Prof. Franz Richarz. (Illustrated)	484
Saturn. By Rev. T. W. Webb. (Illustrated) . . .	485
On Petalody of the Ovules and other Changes in a Double-Flowered Form of " <i>Dianella cærulea</i> ." By Dr. Maxwell T. Masters	487
Musical Scales of various Nations. By Alexander J. Ellis, F.R.S.	488
Notes	490
Astronomical Phenomena for the Week 1885, March 29 to April 4	493
Geographical Notes	493
Accidental Explosions Produced by non-Explosive Liquids, II. By Sir Frederick Abel, C.B., F.R.S.	493
Societies and Academies	496